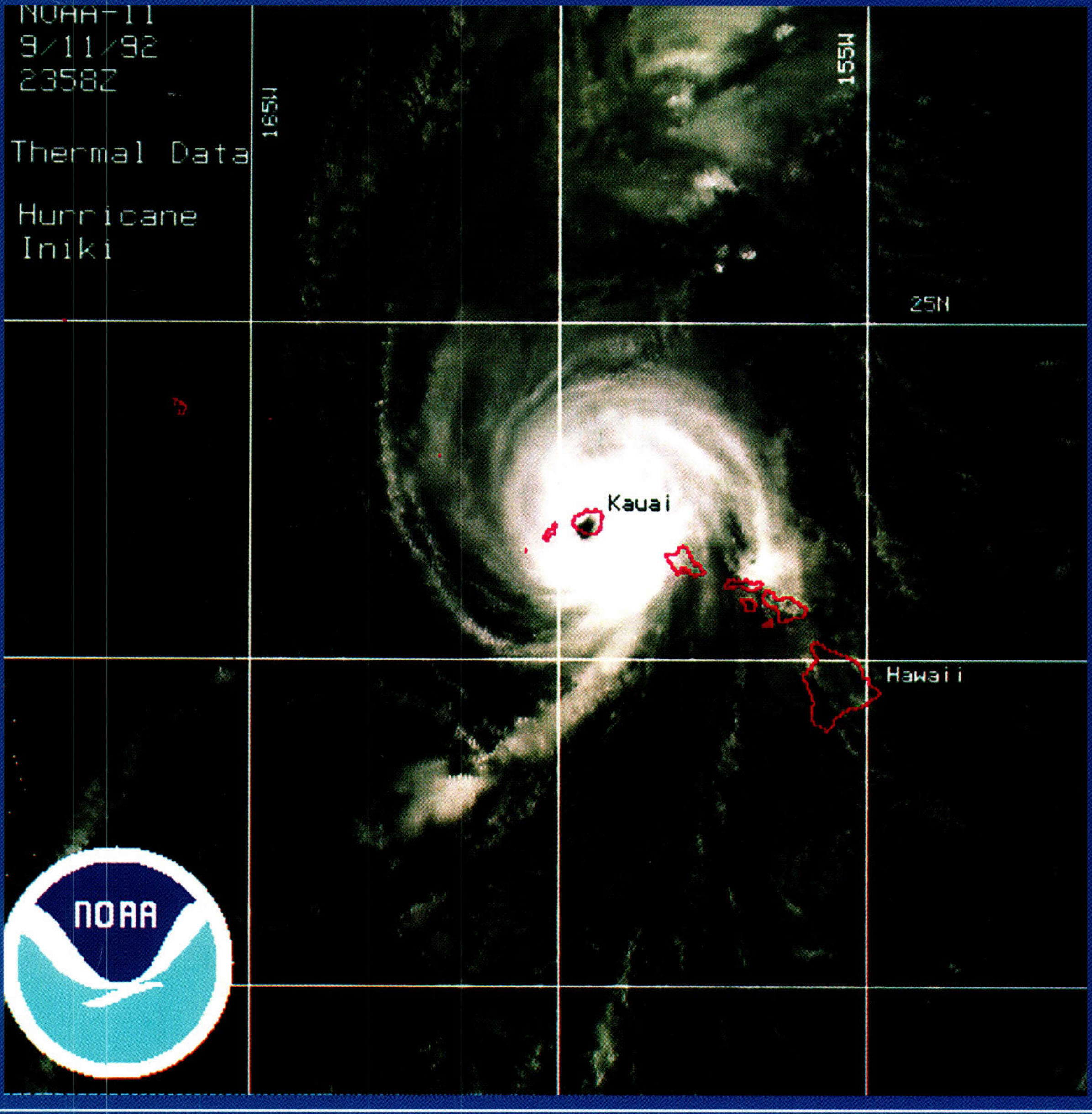
HURRICANE INIKI ASSESSMENT



Review of hurricane evacuation studies utilization and information dissemination

US Army Corps
of Engineers

FEDERAL EMERGENCY MANAGEMENT AGENCY

HURRICANE INIKI ASSESSMENT
Review of Hurricane Evacuation Studies Utilization and Information Dissemination

Prepared for

U.S. Army Corps of Engineers
Federal Emergency Management Agency
and
State of Hawaii, Department of Defense

Prepared by

Post, Buckley, Schuh & Jernigan, Inc.
314 North Calhoun Street
Tallahassee, Florida 32301

September 1993

09-689.00

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SECTION 1
INTRODUCTION

On Friday, September 11, 1992, the strongest and most destructive hurricane to hit the Hawaiian Islands during this century made landfall on the island of Kauai. Hurricane Iniki, on the heels of the destruction caused by Hurricane Andrew in Florida and Louisiana, slammed into the south shore of Kauai causing an estimated 1.8 billion dollars in damage, six deaths, and over 1,000 people injured. About 1,500 homes were destroyed with thousands of dwelling units sustaining significant damage. Although most of the devastation was confined to Kauai, the leeward coast of the island of Oahu also sustained several million dollars worth of property damage.

Prior to Hurricane Iniki, a comprehensive hurricane evacuation study had been completed for the south shore of Oahu and was nearing completion for the eastern (windward) and northern side of the island. Although a comprehensive study had not been developed for Kauai or the western (leeward) side of Oahu, some preliminary hurricane storm surge/wave studies had been accomplished for southern Kauai in 1986. The hurricane evacuation studies developed for portions of Oahu were jointly prepared by the U.S. Army Corps of Engineers, Pacific Ocean Division and the State of Hawaii Department of Defense Civil Defense Division. Financial support for the studies was obtained from the Federal Emergency Management Agency (FEMA) and the U.S. Army Corps of Engineers. Corps of Engineers staff served as study managers for each of the efforts with major logistical support provided by State Civil Defense staff.

Since Iniki directly affected areas that did not have the benefit of Corps/FEMA comprehensive hurricane studies, the breadth of this report is somewhat limited. However, since previous study data was available for portions of Oahu that had been evacuated, there were several key questions which needed to be addressed:

- Did local and state officials use any of the data already produced in Corps/FEMA studies?

- Were study data regarding storm hazards, shelter information, evacuation clearance time, and decision making accurate and reliable?
- What Iniki evacuation data is available for Kauai and leeward Oahu that might be relevant to future FEMA/Corps studies in these two areas?

To answer these questions a study team comprised of Gene Zeizel and William Massey representing FEMA, Steve Yamamoto representing the Pacific Ocean Division of the U.S. Army Corps of Engineers and Mel Nishihara representing the State of Hawaii, Department of Defense visited with state and local officials on Kauai and Oahu. Don Lewis of Post, Buckley, Schuh & Jernigan, Inc. accompanied the study team and documented all relevant findings. Major technical contributions to the effort were provided by Glenn Trapp of the National Weather Service and Scott Sullivan of Sea Engineering, Inc. A report entitled Hurricane Iniki, Action and Response prepared by the City and County of Honolulu under the direction of Major Frank Fasi, was of major help to the assessment effort. Appendix A lists those individuals who attended meetings at the Mayor of Kauai's office, State of Hawaii Civil Defense Office, and Oahu's Civil Defense Office. (A graphic at the conclusion of this introduction shows scenes from the coordination meeting and field review on Kauai.)

Discussion with local emergency management officials focused on facts regarding the evacuation and study products that might have impacted the evacuation decision process, traffic control and clearance, sheltering, and public information. They also addressed the types of material and public information they could have used that had not been developed or delivered to them yet.

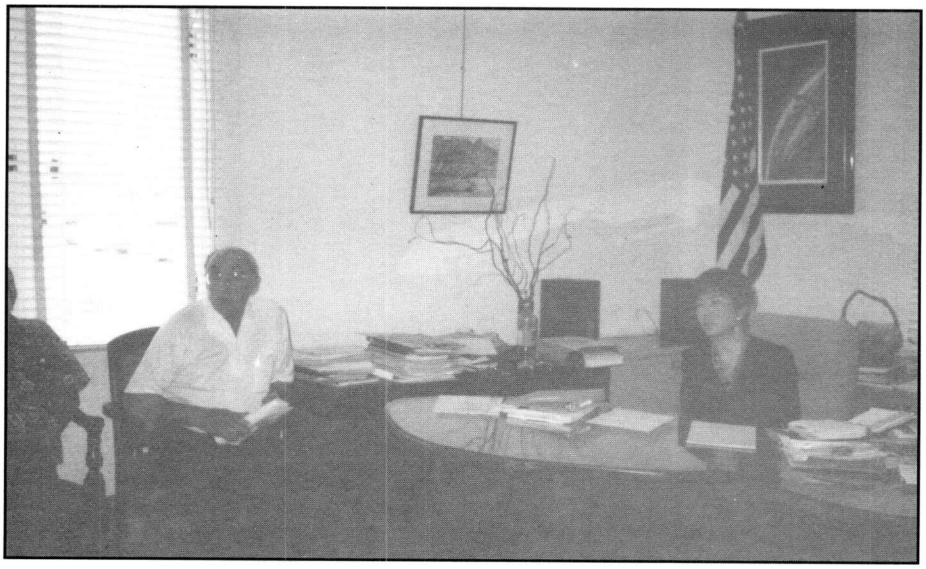
Unlike some previous post-storm assessments, this effort did not include a residential behavioral survey to gauge actual response. It is anticipated that a significant behavioral analysis will be a part of the upcoming leeward Oahu hurricane evacuation study. This effort will gauge Iniki response and will suggest behavioral response parameters which should be used for planning purposes. A behavioral analysis is also likely to be a significant part of a future Kauai study effort.

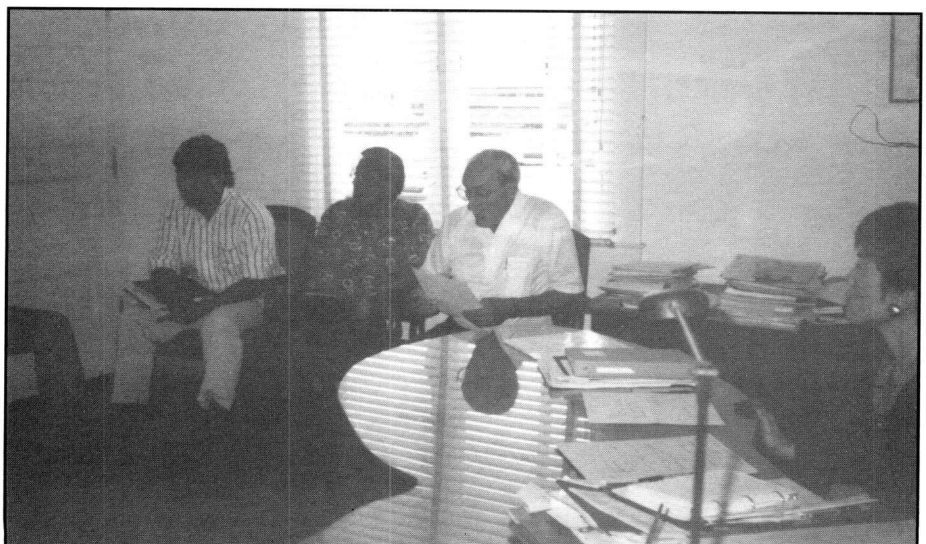
This report documents the major findings of the study team and is organized by general category of hurricane evacuation analysis. Those general categories that are addressed include:

- Hazards/Vulnerability Data
- Shelter Issues
- Transportation/Clearance Time Data
- Evacuation Decision Making and Public Notification/Information

Representative Scenes at Local Coordination Meetings

Representative Scenes at Local Coordination Meetings





Representative Scenes at Local Coordination Meetings

SECTION 2

HAZARDS/VULNERABILITY DATA

(Paraphrased summary and conclusions from Sea Engineering July 1993 report entitled *Hurricane Iniki: Coastal Inundation Modeling*)

In FEMA/Corps comprehensive hurricane evacuation studies, the primary objective of the hazards analysis is to determine the probable worst-case effects for the various intensities of hurricanes that could strike an area. Specifically, a hazards analysis quantifies and maps the expected hurricane-caused coastal inundation that would require emergency evacuation of the vulnerable population. Along portions of the island of Oahu and Kauai, hazards analyses have been conducted which map the expected inundation limits for model and worst-case storm tracks and intensities. Much greater emphasis has to be placed on the wind and wave effects in these studies compared to the emphasis on surge heights in Atlantic and Gulf Coast FEMA/Corps hurricane studies. This is due to the unique topographic, bathymetric and coastal features found in the Hawaiian island chain.

After Hurricane Iwa in 1982, the U.S. Army Corps of Engineers undertook studies to predict the flooding that hurricanes might generate for various locations throughout the islands. Sea Engineering, Inc. used modeling techniques to predict the specific vulnerability of the south coast of Kauai. For the post-Iniki assessment, the Corps retained Sea Engineering, Inc. to compare Iniki's actual storm characteristics and effects with study predicted parameters. The following is an abbreviated version of their summary and conclusions:

> "Considerable quantitative storm data was obtained during Iniki, meteorological and oceanographic data both offshore as the storm approached Hawaii, and onshore as the storm passed over Kauai. This data permits calculation and calibration of various storm parameters necessary for input to the models, as well as excellent verification of the model calculated storm parameters and water level rise and wave runup at the shore. The data included wind speed and direction, deepwater wave height and period, atmospheric pressure changes, water level rise, and a storm wave debris line indicating maximum uprush of the storm waves in the Poipu area.

The detailed storm data for Iniki permitted very accurate estimation of the radius of maximum wind, and the wind and wave models were then calibrated and verified by the available deepwater wind speed and wave height data. Good wind and wave field model correlation was obtained for National Data Buoy Center (NDBC) buoys located south of Hawaii and on both sides of the storm track.

The estimated landward storm wave inundation limits in the Poipu area were mapped by the Kauai County Planning Department following Iwa in 1982, primarily based on the debris line. Similar investigations were accomplished following Iniki by the U.S. Army Corps of Engineers and others, and a good estimate of the Iniki debris line is available. The debris line is considered to represent the maximum runup of storm waves on the shore, and thus the inundation or flooding of the coastal area by storm waves and elevated water levels during the storm. Comparison of the debris lines for the two storms shows considerable similarity between them, particularly in the more extensively developed eastern Poipu shoreline between Makahuena Point and Koloa Landing, where the debris lines are essentially the same. On the western half of the Poipu shore the Iniki debris line was further inland, approximately twice the distance of the Iwa debris line. Thus, although Iniki was considerably more intense in terms of wind speed than was Iwa, the storm wave inundation as evidenced by the debris line was similar for the two storms.

Comparison of the Iniki debris line and the scenario hurricane inundation limits as reported by Sea Engineering, Inc. (1986) shows very similar predicted flooding for the model scenarios hurricanes. The predicted inundation limits for the worst case scenario hurricanes generally exceed the Iniki debris line.

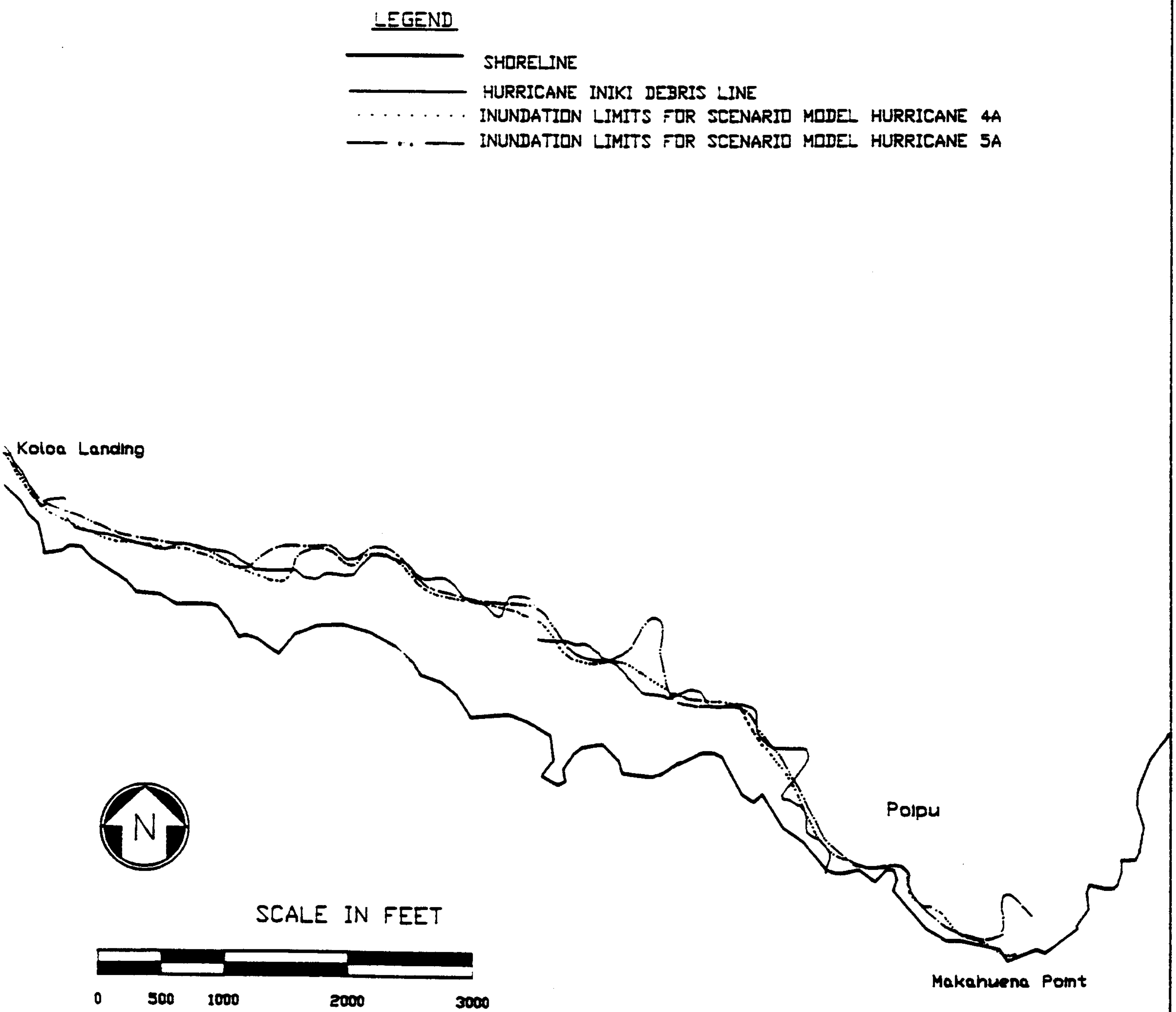
Extensive model verification was possible because of the availability of actual measurements made before and during Hurricane Iniki's landfall on Kauai. Data is available both offshore from the NDBC buoys (atmospheric pressure, wind speed and direction and wave height and period), and at the shoreline from tide and weather stations located at Port Allen and Nawiliwili Harbors and Lihue Airport (atmospheric pressure, wind speed and direction, and stillwater levels at the harbor tide stations). In addition, detailed investigations made after the storm provide data on the inland extent of storm wave runup.

The overall correlation between the model predictions and actual measurements during Iniki is considered very good. The correlation between predicted runup and inundation limits and the actual storm debris line must be qualified however. Although there is on the average a good correlation between the predicted runup at Poipu and the debris line, there are significant differences for some of the shoreline profile lines modeled. Based on the debris line, the model more often over predicted, rather than under predicted, the storm wave runup and inundation at Poipu. The primary explanation for this is believed to be significant differences between the 1975 topographic data used in the model

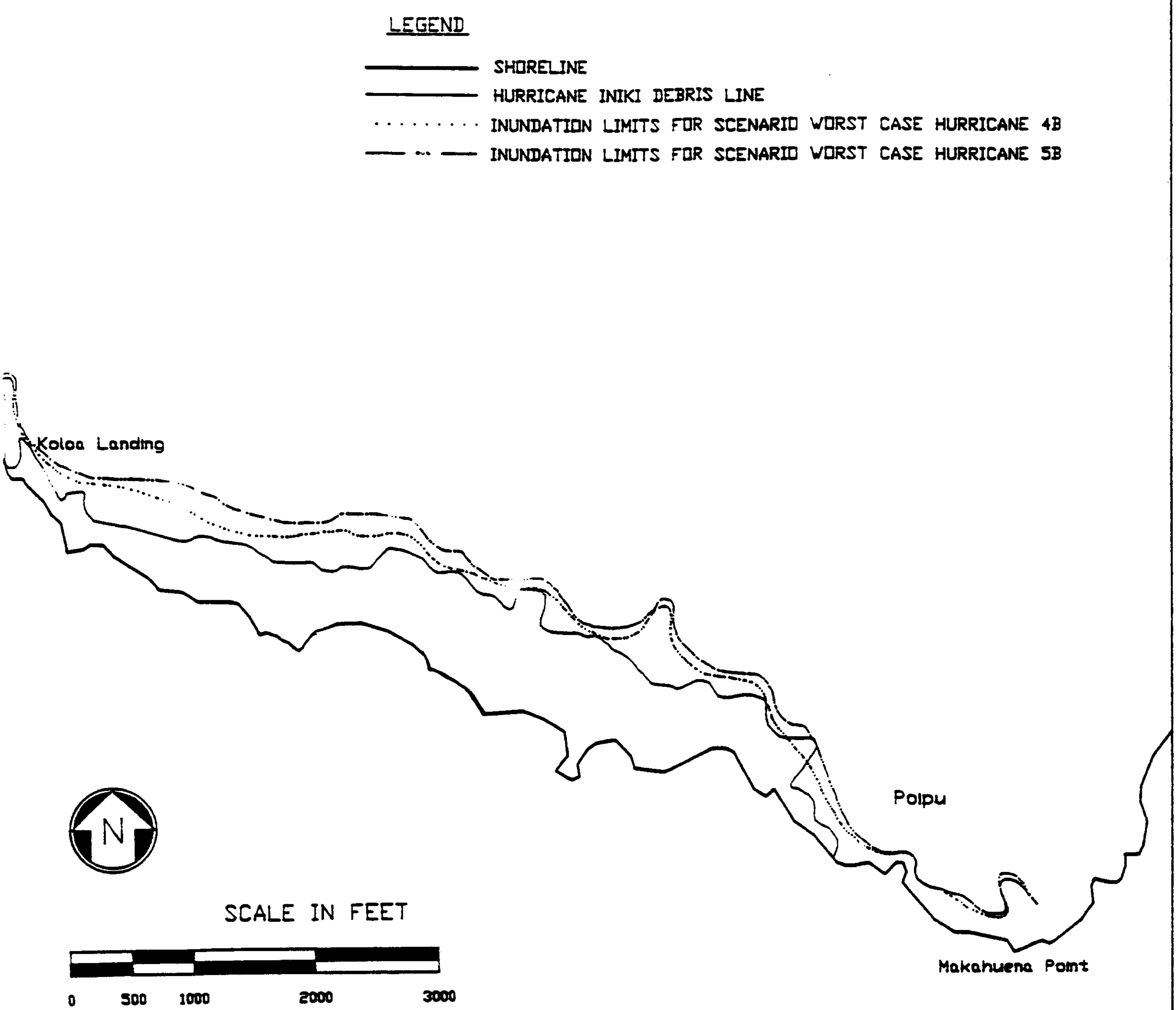
> and the actual present day topography existing along portions of the coast that have been altered by development during recent years. The model also did not consider the blocking and/or energy dissipating effects of nearshore buildings and other structures which likely decreases wave runup."

In addition to the summary and conclusions presented in the Sea Engineering, Inc. July 1993 report, many excellent tables and figures were presented. The graphs from that report which compare the Iniki debris line with model and worst case predicted inundation limits are included within this report. Appendix B provides key tables and charts provided by the National Weather Service and Sea Engineering, Inc. regarding Iniki's characteristics and includes the following:

- Hawaii Historical Hurricane Storm Tracks and Data
- Hurricane Iniki Best Track
- Hurricane Iniki Track Data
- Water Level/Barometric Pressure at Port Allen
- Water Level/Barometric Pressure at Honolulu
- Waves and Tides - general data
- Winds - general data.



HURRICANE INIKI DEBRIS LINE VERSUS
INUNDATION LIMITS FOR SCENARIO MODEL HURRICANES



HURRICANE INIKI DEBRIS LINE VERSUS
INUNDATION LIMITS FOR SCENARIO WORST CASE HURRICANES

SECTION 3
PUBLIC SHELTERING

The primary objectives of shelter analyses prepared for FEMA/Corps comprehensive hurricane evacuation studies are to list public shelter locations, assess their vulnerability relative to storm surge flooding, and to estimate the number of people who would seek local public shelter for a particular hurricane intensity or threat. Shelter location/capacity data are obtained from local emergency management staff working in conjunction with the American Red Cross, schoolboard or other local agencies. Comparisons are then made with surge modeling data to assess the flooding potential. Public shelter capacity is usually compared to public shelter demand figures generated in the transportation analysis to determine potential deficits or surpluses in sheltering. Behavioral assumptions for the transportation analysis regarding the percent of evacuees going to public shelter come from the behavioral analysis or behavior parameters recommended by the local directors.

Shelter issues related to Iniki were discussed with local officials. Discussions focused on the following topics:

- When were shelters opened and when did evacuees arrive/stop arriving?
- How many people were sheltered and how many shelters opened?
- Were any problems encountered with shelters during the storm?

On Kauai local officials reported that 8,000 people were in shelters immediately before Iniki's arrival. After the storm, 12,000 people were accommodated in public shelters. Shelters were extremely crowded and people were fearful of the approaching hazards of Iniki. Many remembered the effects of Hurricane Iwa in 1982. Local officials stated that more shelters need to be identified and more shelter managers will need to be trained. If another hurricane should threaten Kauai within the next few years, officials believe that many more residents and tourists will seek public shelter. It should be noted that rather than sending tourists to public shelters during Iniki, two major hotels (the Hyatt and Westin properties) sheltered their occupants in-place. The Princeville Sheraton Hotel was designated a public shelter via an understanding by hotel management and the County of Kauai/American Red Cross on Kauai.

On Oahu, 110 public shelters were opened and approximately 30,000 people sought public shelters for their evacuation destination. Even though the evacuation of the leeward (west) coast did not officially start until 9 a.m., evacuees began arriving at shelters before 6:00 a.m. a.m. shortly after sirens had been sounded. By noon, some shelters were reported full, although no shelters reached maximum capacity (assuming 10 square feet per person).

Shelters were staffed primarily by City Department of Parks and Recreation employees with some support from the American Red Cross, State Education Department, the Salvation Army, and volunteers from the University of Hawaii. Shelters on Oahu were opened as "refuge only" shelters primarily in public school buildings and in that regard did not provide food, cots, blankets, medications or other comfort items. As sustained tropical storm winds arrived, police officers were moved off the streets and into the shelters to help with security.

Considering the magnitude of the sheltering operation, local officials should be commended for how well the shelter plan worked. Issues that need further planning and attention include the following:

- need for more shelter managers
- lack of telephone or other communication equipment/inability to communicate with EOC staff.
- parking problems at some shelters.
- making sure public understands that no pets are allowed in shelters.
- maintaining security in classrooms.
- inadequacy of some restrooms in accommodating disabled persons.
- communication with some local radio stations as to which shelters are open.
- making sure public understands that special medical attention/needs are not available at shelters.
- familiarity of shelter managers with shelter facilities.

Officials roughly estimate that a third of the population on Oahu participated in the evacuation. Many went to the home of a friend or relative. The FEMA/Corps studies already completed for portions of Oahu, calculated a public shelter demand of roughly 80,000 people which was more than the 30,000 people that actually went to public shelter. Without a post storm behavioral assessment it is difficult to pinpoint why the difference occurred. Clearly participation from the Waikiki area and many wind only vulnerable areas was much less than assumed in the scenarios tested. Guidance given to hotels in Waikiki lowered the number of evacuees. People living in tsunami evacuation zones were asked to evacuate for Iniki. In the previous studies, the least intense evacuation scenarios assumed 100% of these people plus 30 to 40 percent of the wind vulnerable areas participating in an evacuation. Perhaps a broader range of participation and public shelter rates should be treated in future studies for the Hawaiian islands.

SECTION 4

TRANSPORTATION CLEARANCE TIME DATA

In FEMA/Corps comprehensive hurricane evacuation studies, the primary objective of the transportation analysis is to determine the clearance times needed to conduct a safe and timely evacuation for a range of hurricane threats. Information from the hazards, vulnerability, shelter, and behavioral analyses are directly input as well as various sources of permanent and seasonal population data. For the Oahu studies, clearance times were developed for four response levels of evacuation and stratified by two levels of background traffic occurring at the time of a hurricane evacuation.

Discussions with local officials on Kauai and Oahu, focused on transportation data related to the Iniki evacuation. For Oahu, study produced data were compared to actual Iniki, data and revolved around responses to these questions:

- Was the evacuation roadway network accurate - did evacuees use projected travel routes?
- Were any traffic control actions taken to speed up flow?
- When was the evacuation essentially completed and how long did the evacuation take?
- Were any major traffic problems encountered in this evacuation?

On Kauai no major traffic problems were reported. Upon issuance of a hurricane watch on Thursday, traffic picked up as residents went to local stores for food and supplies. Sirens sounded and EBS was activated before 6:00 a.m. Friday, causing many residents to begin leaving homes and entering public shelters. Some residents went to their workplace for sheltering, bringing their families with them. Since schools had been canceled for the day, background traffic was light. Local officials reported that the streets on Kauai were cleared by 11:15 a.m.

On Oahu, sirens were sounded at 5:30 a.m. on Friday, September 11th to alert residents of a hurricane warning. At 9 a.m., the evacuation of the leeward coast was announced over EBS. At 9:45 a.m. sirens sounded again and EBS announced the evacuation of all other

Oahu risk areas. People started arriving at public shelters before 6:00 a.m. and most evacuation movements had been completed by noon. Local emergency management officials reported that study calculated clearance times were realistic and workable for the Iniki evacuation. The 4-1/4 to 6-1/4 hour clearance time frame did match up well with observed evacuation traffic flow.

Few traffic problems were reported for Oahu but this is most certainly a function of the following factors:

- areas asked to evacuate were limited primarily to the immediate coastal areas (tsunami and 300 ft. zone areas) around the entire island.
- police manned critical traffic control points using those locations suggested in the FEMA/Corps studies as a starting point.
- the city bus system and the Handi-Van provided free transportation to emergency shelters for those in need.
- participation in the evacuation on the part of Waikiki visitors and residents was extremely limited.
- timely notification of agencies and the public allowed the evacuation to begin well in advance of hazardous conditions.
- outstanding public information effort that began 3 days before storm arrival.

Two transportation issues which were mentioned as planning items for a future Oahu evacuation included increased parking at several shelters and the need for alternate exit routes for leeward, north shore, and windward coast residents. An upcoming FEMA/Corps hurricane vulnerability study for the leeward coast should assist with the routing concern. This study will take place over the next year as funding is made available.

SECTION 5

EVACUATION DECISION MAKING AND PUBLIC INFORMATION/NOTIFICATION

Some of the most important products developed as part of the Atlantic and Gulf Coast FEMA/Corps hurricane evacuation studies and delivered to local and state officials have been evacuation decision making tools. These tools are decision arc maps and tables as well as computer software such as HURREVAC. Products such as these graphically tie together real-time storm characteristics with clearance time data. Their purpose is to give emergency management directors a means of retrieving Technical Data Report information without having to dig through a report during an emergency. Evacuation decision tools provide guidance and assistance to decision makers as to when an evacuation should begin relative to a specific hurricane, its associated wind field, forward speed, probabilities, forecast track, and intensity. Although these products have not been developed for the Hawaiian islands as of yet, as comprehensive studies are finalized for Oahu the appropriateness of these products should be considered by federal, state, and local officials.

Evacuation decision making for Iniki relied heavily on storm track data as well as watches and warnings provided by the Central Pacific Hurricane Center of the National Weather Service. A total of 28 bulletins were issued by the National Weather Service Forecast Office reporting the information and path of the storm. As early as Monday, September 7, 1992 Oahu Civil Defense notifications were being given to key agencies and departments. Oahu had staff in place Wednesday evening. Both Oahu and Kauai officials briefed department heads fully on Thursday as the storm took a more northerly turn. Emergency operations centers were opened Thursday evening as watches became warnings for both islands.

The following means of notification and warning were used on Oahu and Kauai to alert the public:

- Emergency Broadcast System
- Outdoor siren warning system

- U.S. Telecom Notifier System and FAX transmissions to radio and television stations
- Amateur radio operators (HAM) transmissions/relays
- Neighborhood notifications by loudspeaker for siren "gap" areas (local police and civil defense volunteers provided this means)
- Pre-formatted emergency information and instructions for EBS broadcast.
- Emergency information for the deaf and hearing impaired on KHON-TV Channel 2
- Communications by volunteers of the Radio Amateur Civil Emergency Services (RACES)
- Notification of clients by social service agencies

Areas of public information/notification that officials felt needed to be addressed for future evacuations included:

- further education of public about flood prone areas
- education of hotel management and visitors about the danger of staying in some waterfront hotels during storm events
- multi-lingual/cultural "audience" on islands/how to communicate instructions that can be understood
- familiarity with meteorological nomenclature (hurricane, typhoon, cyclone, tropical storm, depression, disturbance, etc.)
- communications equipment available during storm
- public shelter announcements/instructions
- make sure public understands that no pets are allowed at shelters and that food/medication generally will not be provided
- public should not leave shelters until hazardous conditions are eliminated and Civil Defense has given the "all clear" signal

APPENDIX A

Meeting Attendees/Persons Providing Assessment Impact

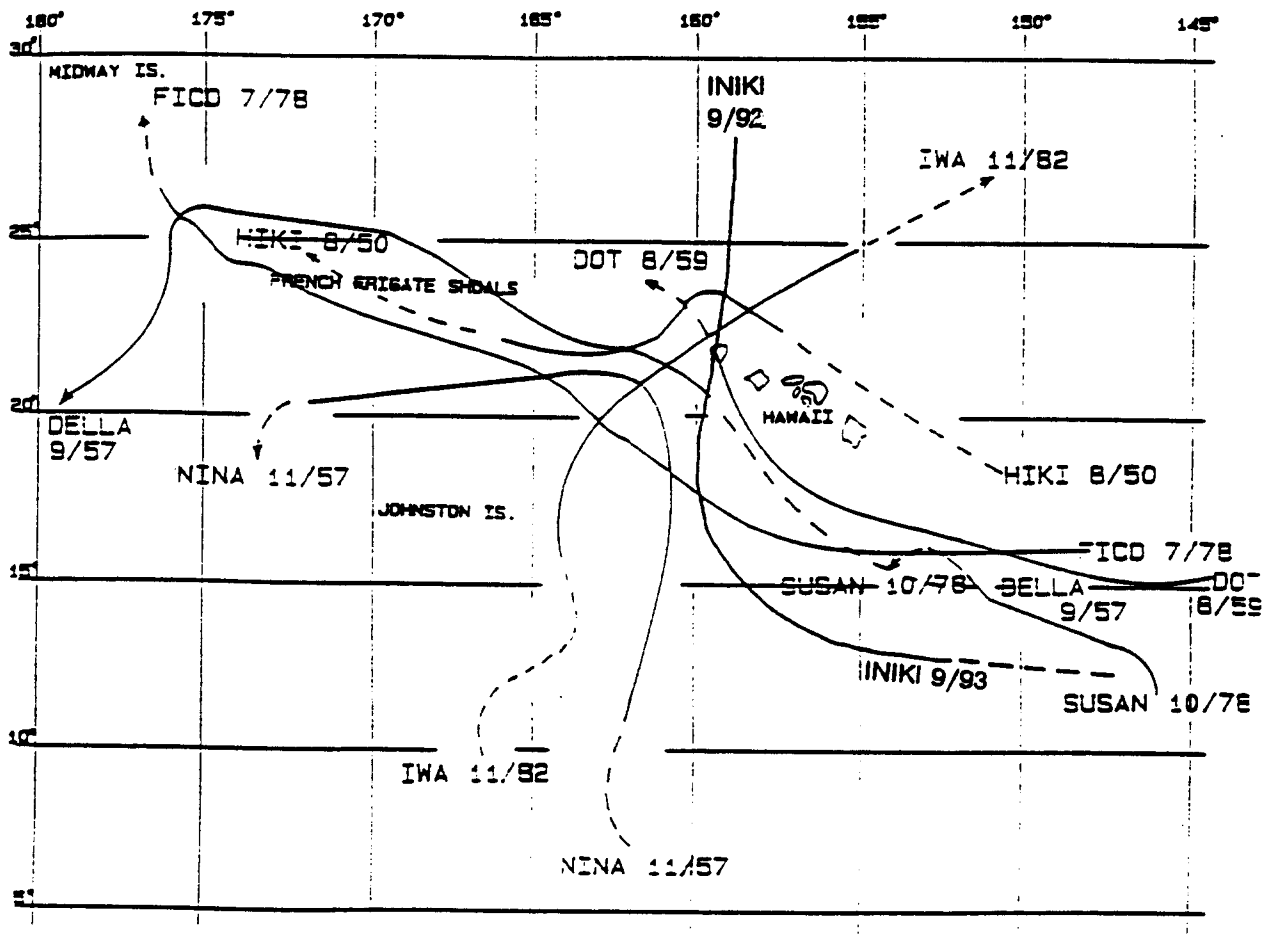
Study Participants/Meeting Attendees

Roy C. Price, Sr.	Vice Director State Civil Defense	(808) 734-2161
Bill Massey	FEMA - Region IV	(404) 853-4430
Gene Zeizel	FEMA - HQ	(202) 646-2802
Scott Sullivan	Sea Engineering, Inc.	(808) 259-7966
Don Lewis	Post, Buckley, Schuh & Jernigan, Inc.	(904) 224-7275
Steve Yamamoto	U.S. Army Corps of Engineers	(808) 438-8866
Glenn Trapp	National Weather Service Honolulu	(808) 541-1698
Mel Nishihara	Hurricane Program Manager State Civil Defense	(808) 734-2161
Dee Crowell	Planning - Kauai	(808) 245-3910
Kiyosi Masaki	Public Works - Kauai	(808) 241-6616
Tom Batey	Admin. Asst. - Kauai Mayor's Office	(808) 248-6300
Jo Ann Yukimura	Mayor - Kauai	(808) 241-6300
Sonny Gerardo	Administrator KCDA	(808) 241-6336
Paula Loomis	City Managing Director	(808) 527-5759
Frank Apel	Oahu Civil Defense Agency (OCDA)	(808) 523-4121
Malcolm A. Sussel	Administrator OCDA	(808) 523-4121
Joseph D. Reed	OCDA	(808) 523-4124

APPENDIX B

National Weather Service/Sea Engineering Iniki Graphics and Tables

HISTORICAL HURRICANE CHARACTERISTICS						
Name	**Date**	**Sustained Wind Speed (kts)**	**Lowest Sea Level Pressure (mbs)**	**Direction**	**Forward Speed (kts)**	**Eye Diameter (NM)**
HIKI	8/50	65	983	WNW	5	10-20
DELLA	9/57	-	-	NW	6	-
NINA	11/57	80	-	NNW	8	-
DOT	8/59	65	984	NNW	9	20-30
FICO	7/78	100	955	WNW	10	30
SUSAN	10/78	120	954	NW	6	10-20
IWA	11/82	65	972	NE	32	20-30
INIKI	9/92	100	945	N	20	10

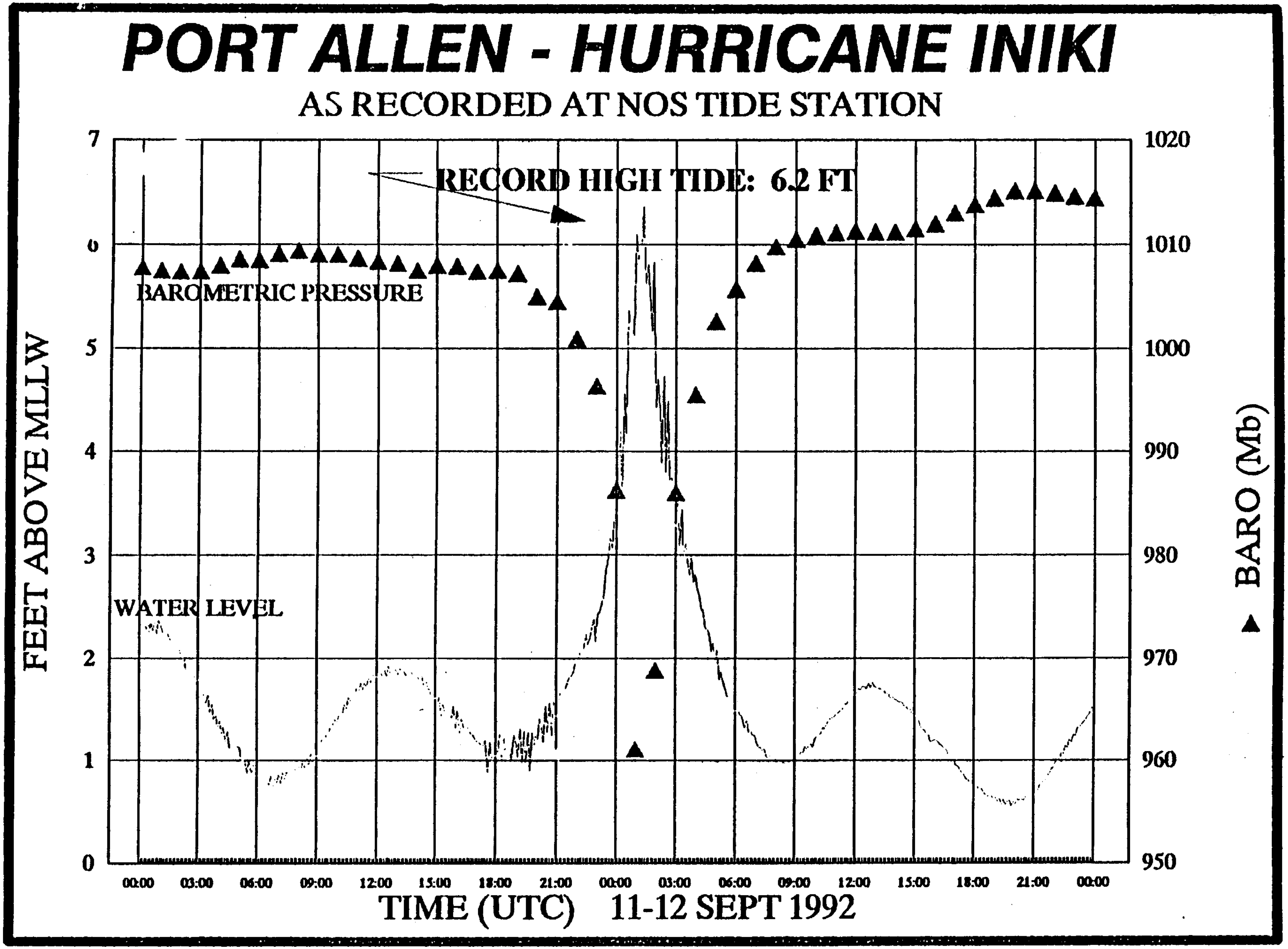


HISTORICAL HURRICANE STORM TRACKS

HURRICANE INIKI BEST TRACK

September 6-13, 1992

DATE/TIME (UTC)	ACTUAL TRACK LAT LONG	BEST TRACK LAT LONG	MAX WIND KNOTS	MIN SLP MB
06/1800	10.2N 140.0W	12.2N 140.0W	30	1008 - est
07/0000	12.5N 141.0W	12.3N 141.1W	25	1008 - est
0600		12.3N 141.7W		
1200		12.2N 142.4W		
1800	11.5N 143.0W	12.1N 143.0W	30	1004 - est
08/0000	12.0N 144.5W	12.0N 144.5W	35	1002 - est
0600	12.2N 145.8W	12.0N 146.0W	40	1000 - est
1200	12.2N 147.5W	12.1N 147.5W	40	1000 - est
1800	12.4N 149.0W	12.3N 149.0W	50 G65	996 - est
09/0000	12.4N 150.2W	12.4N 150.2W	60 G75	996 - est
0600	13.0N 151.5W	12.7N 151.6W	65 G80	992 - est
1200	13.2N 152.9W	13.0N 152.9W	65 G80	992 - est
1800	13.5N 154.2W	13.4N 154.3W	80 G100	984 - est
10/0000	14.0N 155.4W	13.8N 155.5W	85 G105	980 - est
0600	14.6N 156.9W	14.3N 156.9W	90 G110	960 - drop
1200	14.9N 158.1W	14.7N 157.8W	100G125	960 - est
1800	15.2N 158.7W	15.2N 158.6W	100G125	951 - drop
11/0000	15.9N 159.3W	15.9N 159.3W	110G135	948 - drop
0600	16.8N 159.5W	16.8N 159.8W	115G140	939 - drop
1200	18.2N 160.2W	18.2N 160.2W	120G145	938 - drop
1800	19.5N 159.9W	19.5N 160.0W	125G150	938 - drop
12/0000	21.5N 159.7W	21.5N 159.8W	115G140	945 - drop
0600	23.7N 159.4W	23.7N 159.4W	100G125	959 - drop
1200	25.7N 159.0W	25.7N 159.0W	80 G100	980 - est
1800	28.1N 158.9W	28.1N 158.9W	80 G100	980 - est
13/0000	30.4N 158.7W	30.4N 158.8W	65 G80	990 - est
0600	33.0N 158.7W	33.0N 158.7W	65 G80	990 - est
1200	35.0N 158.5W	35.0N 158.5W	50 G[illegible]5	1000 - est
1800	[illegible].7N 158.1W	36.7N 158.1W	40	1002 - est


PORT ALLEN - HURRICANE INIKI
AS RECORDED AT NOS TIDE STATION
RECORD HIGH TIDE: 6.2 FT
BAROMETRIC PRESSURE
WATER LEVEL
FEET ABOVE MLLW
BARO (Mb)
TIME (UTC) 11-12 SEPT 1992
7
5
4
3
2
1
0
1020
1010
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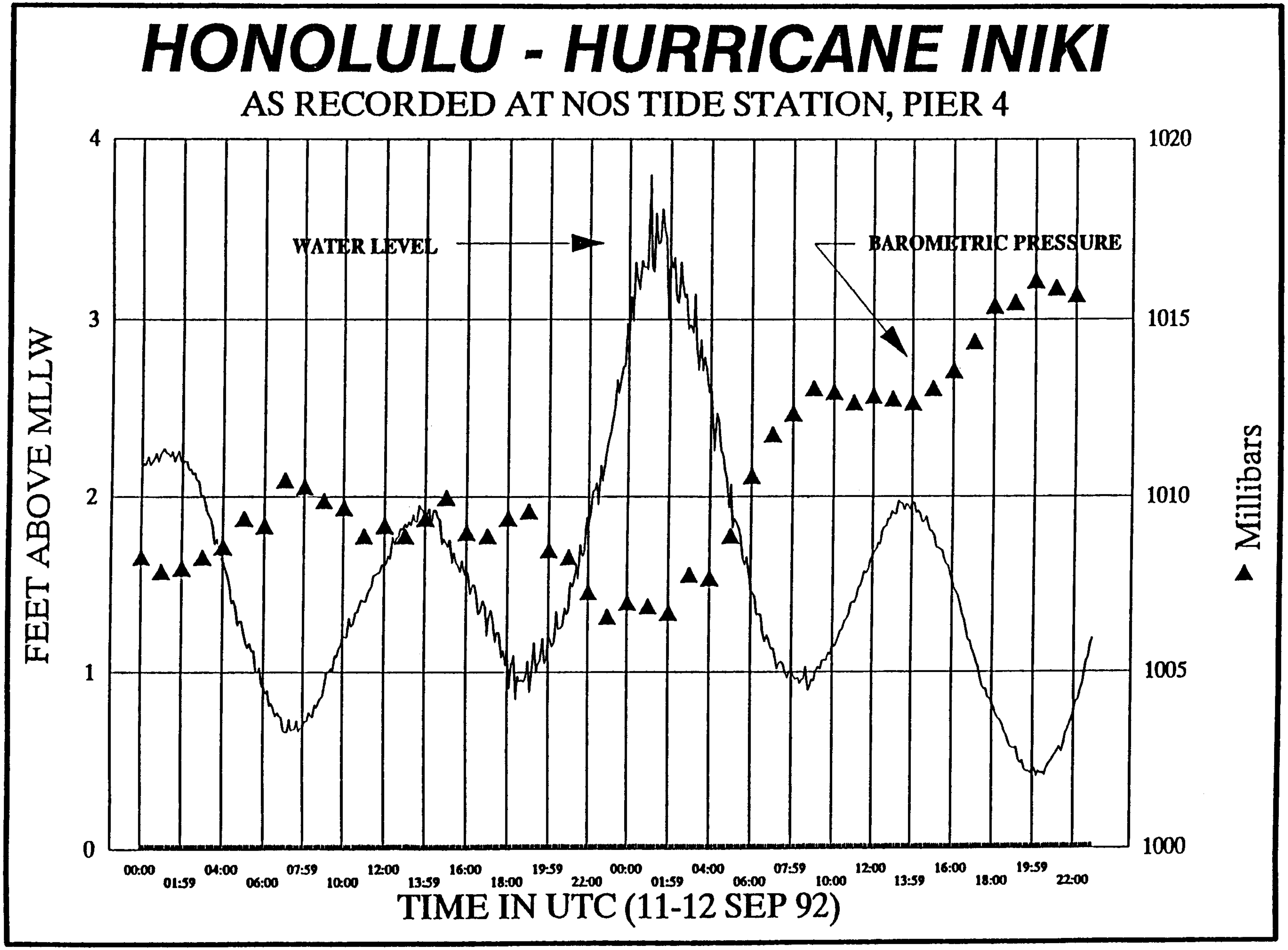
HONOLULU - HURRICANE INIKI
AS RECORDED AT NOS TIDE STATION, PIER 4
WATER LEVEL
BAROMETRIC PRESSURE
FEET ABOVE MLLW
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1
2
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4
1000
1005
1010
1015
1020
▲ Millibars
00:00
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16:00
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22:00
00:00
01:59
04:00
06:00
07:59
10:00
12:00
13:59
16:00
18:00
19:59
22:00
TIME IN UTC (11-12 SEP 92)

Waves and tides

Tides

Kauai - Tides 4.5 to 6.0 feet above normal

Oahu - Tides 1.7 to 3.0 feet above normal

Significant wave height near 20 feet.

Maximum wave height near 35 feet.

Surf height report 20 to 30 feet.

Inundation levels on Kauai 10 to 22 feet.
Greatest inundation near Poipu

High water marks ranged from 10 to 18.5 feet.

Winds

Peak Winds

Recon report 130mph gusts to 160mph at landfall.

Point Makahuena 090/70kts gusts 105 kts 230pm.
81mph 121mph

Peak Gust 124kts (143mph) after 230pm.

Lihue Airport 150/73kts gusts 99 kts at 355pm
84 mph 114mph.

Instrument pegged at 102+ kts at 302pm & 510pm.

Estimated Gusts 112kts(129mph) at 302pm and 106 kts (122mph) at 510pm HST.

Barking Sands 275/60 kts gust to 87 kts at 505pm